

Beyond the SAMBA Statement: Perioperative Glucose Management for Diabetes Patients

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Diabetes is Prevalent

- In 2015, 30.3 million Americans, or 9.4% of the population, had diabetes.
- Approximately 1.25 million American children and adults have type 1 diabetes.
- Undiagnosed: Of the 30.3 million adults with diabetes, 23.1 million were diagnosed, and 7.2 million were undiagnosed.
- Prevalence in Seniors: The percentage of Americans age 65 and older remains high, at 25.2%, or 12.0 million seniors (diagnosed and undiagnosed).

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The SAMBA Consensus Statement Considered 13 Questions

A&A 2010

- What Stayed the same?
- What's Changed?
- What's New?
- Personal Edits/Comments

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Primary Goals of Perioperative Glucose Management for Ambulatory Pts

Avoidance of Hypoglycemia



Maintenance of Adequate Blood Glucose control

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What if Any, Preoperative info on
Glucose Control should be Obtained?

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Preoperative Inquiries: Diabetes Management

- Adherence to medications
- Self-management skills
 - Frequency of self-testing
 - Active role in managing BG
 - Complicated vs. simple regimens

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**Standards of Care:
Glycemic Control = HbA1c**

- Standard of Care: every 3-6 months
- Goal for Control: $\leq 7\%$
 - Only 41-57% of adults reach this level
- Options
 - Logbook
 - Spot Glucose or Ask

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Is There a Preop Blood Glucose Level Above Which One should Postpone Elective Surgery?

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Why do we care about high blood glucose level during ambulatory surgery?

- Complications of hyperglycemia
 - Dehydration, ketoacidosis, hyperosmolar state
- Adequacy of long term control
- Chronic hyperglycemia (poor control) periop implications
 - Infection
 - Delayed wound healing
 - Risk of acute reductions

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What to do with a High Blood Glucose??

- Cancel Surgery
- Delay Surgery
- Treat
- Ignore

- Risks of Hyperglycemia at home

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What Are the Other Considerations Specific to Glycemic Control?

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Classification of Hypoglycemia

Level	Glycemic criteria/description
Level 1	Glucose <70 mg/dL (3.9 mmol/L) and glucose \geq 54 mg/dL (3.0 mmol/L)
Level 2	Glucose <54 mg/dL (3.0 mmol/L)
Level 3	A severe event characterized by altered mental and/or physical status requiring assistance

American Diabetes Association
Diabetes Care 2019

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Hypoglycemia

Ask: Incidence and frequency

Ask: BG at which symptoms occur

- Type of symptoms

Extra Caution

- Old age, Female gender

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Avoiding Hypoglycemia

- Self-testing
- Travel with treatments
 - Appropriate treatment: 15-20 gm CHO
 - 6-8 oz juice, sugary drink
- Glucose tablets and most glucose gels = particulate AVOID
- 250 cc D5w = 12.5 gm CHO
- 50cc D50 = 25gm CHO

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Hypoglycemia Unawareness

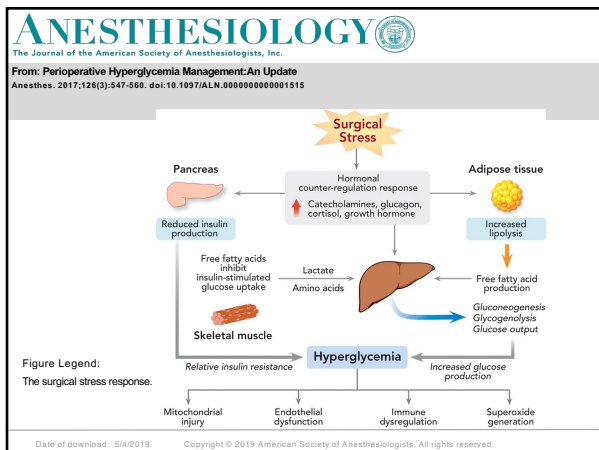
- Tightly controlled Type 1 diabetes
 - Rare in Type 2
- Absent or insufficient counter-regulatory hormones and/or diminished autonomic response
- Reversal with less tight control
- **NOT** same as: Upward shift in threshold for symptoms in type 2 **XXXXXXXXXX**

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Are YOU Causing Hyperglycemia?

- Stress and Fasting → Insulin resistance, decreased secretion, increased glucose production
- Dexamethasone, other steroids
- PONV
- Pain
- General Anesthesia*****
- Withholding Insulin, Antihyperglycemics

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What is Optimal Perioperative Blood Glucose Monitoring?

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Blood Glucose Testing

- Who? and When?
 - Type 1 and 2
 - Arrival
 - Every 1-2 hours



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Use of POC Blood Glucose Monitors in Operating Room

- Compared arterial samples for BG measured by ABG, POC monitor to capillary samples by POC
- POC monitors tended to UNDER estimate BG
- Capillary blood glucose measured using POC meter acceptable for intraoperative subcutaneous insulin dosing
- Hemodynamic stability, no pressors, any length of surgery

Anesthesiology 2017

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Continuous Glucose Monitors

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Continuous Glucose Monitors (CGM)

- Measure BG thru Electrochemical/Enzymatic means
- Inserted into subcutaneous tissue
- May or may not need calibration
- Can communicate with receiver or device (CSII)
 - May be subject to electric interference
- May or may not be useful in OR
- Caution with APAP

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How Should we Identify and Manage Perioperative Hypoglycemia?

See Above!!!

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What is the Optimal Intraoperative Blood Glucose Level?

- Below 180 mg/dl
- But depends on patient's usual BG values

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How Do We Maintain Optimal Blood Glucose Level?

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TIME OUT!!!!

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Problem: Treating All Diabetes Patients The Same

Diabetes Type

- Type 1: Absolute insulin deficiency
- Type 2: Insulin Resistance → Relative Insulin Deficiency
 - Produce basal insulin – no Ketosis
 - Multiple levels of treatment
- Disease duration

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How Do We Manage Preoperative Oral Antidiabetic and Noninsulin Injectables?

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Oral + non-insulin injectable medications

Drug Class	Action	Risk of Hypoglycemia
Biguanide	Sensitizer	Low
Meglitinides	Secretagogue	Yes- Moderate Risk
Sulfonyureas	Secretagogue	Yes- Highest Risk
Thiazolidindiones	Sensitizer	Low
Alpha-glucosidase inh.	Reduce int. absorption	Low
DPP-4 inhibitors	Incretin	Low
GLP-1 receptor agonists	Incretin	Low (risk w insulin)
SGLT-2 receptor inhibitors	Increase glucose excretion (kidney)	Low

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Oral + non-insulin injectable medications

Type 2 diabetics*

- Hypoglycemia rare: caution with **sulfonylureas, meglitinides, injectables**
- No evidence of metformin risk in ambulatory surgery pts.
- Anti-hyperglycemic vs Hypoglycemic
- Take or Hold on day of surgery until food intake resumes

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Specific Risks of Type 2 Medications

SGLT – 2: Selective Sodium Glucose Co-Transporter 2 inhibitors

- Once daily pill
- Canagliflozin – Invokana
- Empagliflozin – Jardiance
- Dapagliflozin – Farxiga
- Prevent Reuptake of glucose from glomerular filtrate
- May be combined with other drugs
- FDA.gov (12/15) **Risk of Ketoacidosis and serious UTI**

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Specific Risks of Type 2 Medications

SGLT -2 Perioperative Considerations

- No evidence
- Assume increased risk of ketoacidosis with surgery
- Other factors: Febrile illness, fasting, pancreatic disorders, reduction in insulin production or dose, EtOH abuse

- Hold dose for 24 hours prior to surgery

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Specific Risks of Type 2 Medications

Long Acting GLP – 1 (Once Weekly Subcutaneous Injections)

Bydureon: microspheres of Exantide

- Takes 6-7 weeks to optimum level
- Release continues for up to 10 weeks after D/C
- Hypoglycemia possible in combination w secretagogue or insulin
- Slows gastric emptying

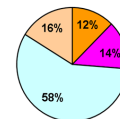
Trulicity: dulaglutide

- Risk of Nausea/Vomiting, Diarrhea

HOLD BEFORE SURGERY (last dose at least 4 days prior to surgery)

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Percentage of adults with diagnosed diabetes
receiving treatment with insulin or oral
medication, United States, 2007–2009



■ Insulin only ■ Insulin and oral medication □ Oral medication only □ No medication

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Ask the Patient on Insulin...

- What Kind(s) of Insulin?
 - Type, brand, dose
 - Physiologic Insulin (Basal/Bolus)
- Self Management Skills?
- **What Happens if you miss a meal?**

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Physiologic Insulin Dosing AKA: Basal/Bolus Insulin

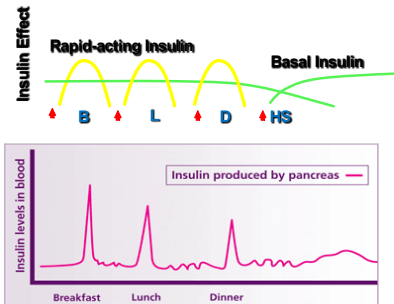
Three elements

- 1) Basal Insulin (Glargine, Detemir, CSII, Degludec)
- 2) Nutritional Insulin (Rapid-acting analogs)
- 3) Correction Insulin (same as nutritional)



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Basal/Bolus Insulin Dosing versus Natural Insulin Secretion



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Basal Insulins Peakless Long Acting Insulins

Glargine

- Acidic Solvent, Altered Isoelectric point, precipitates after injection and slowly re-dissolved and absorbed
- 1x daily in Type 1, 1 or 2x daily in Type 2

Detemir

- Fatty acid side chain reversibly binds albumin and forms hexamers at injection site.
- Slow dissociation
- Once or twice daily (less duration than glargine in Type 1)

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Basal Insulins Peakless Long Acting Insulins

DeGludec

- Forms soluble multihexamer assemblies after injection
- Action duration GREATER than 24 hours (32-48hrs)
- Available with GLP-1 (non insulin injectable)
- More stable insulin levels than glargine
- Less hypoglycemia
- Variable injection schedules*****

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Insulin Dosing: Basal Insulin

Basal Insulin: Covers basal needs **while fasting**

- How do I know??
 - Should be only 50-60% of Total Daily Dose of Insulin
 - Glargine, Detemir, Degludec (not NPH***)
 - Insulin pump at sleep or sick day rate
 - ASK!!!
- Give normal doses of basal insulin at usual times (or 80%)

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Insulin Dosing: Type 2 Supplemental *Not Physiologic*

Basal Insulin: Glargine

- 75% of normal dose even if given once in the evening
 - J Clin Anesth 2017
- 75% of normal morning dose if given twice daily
 - Anesthesiology 2017

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Insulin Dosing: Day of Surgery

Patient to bring own Insulin

- Confirm exact type of insulin
- Administer patient's own insulin*
 - Potency
 - Brand, analog

Maintain basal insulin

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Insulin Dosing: Intermediate-acting NOT Usually Type 1****

NPH and Fixed Combination Insulins

- NPH (Humulin N)
- Humulin 70/30 (NPH/Regular)
- Humalog Mix 50/50 (Lispro protamine/Lispro)
- Early morning case Options:
 - Administer and do case
 - Hold, do case, administer in PACU

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Insulin Dosing: Adjustment

- Intermediate-acting insulin
- Long-acting peakless insulin solely (not basal****)

Uses dosing interval, time of fast (predicted, actual) to determine **fraction of insulin to give**

$$\frac{\text{Dosing interval (hrs)} - \text{Time of fast (hrs)}}{\text{Dosing interval (hrs)}}$$

Vann 2009

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Insulin Dosing: Adjustment (****)

Example

- Patient takes **32 U** of NPH twice daily
- He is expected to eat at 10am (3 hr fast)
- **$\frac{12-3}{12} = \frac{3}{4}$ [of 32 U] = 24 U of NPH**
- Remember NPH peak effect takes 3 hours

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What's Old is New Again

- Skyrocketing prices of insulin
- Deaths, hospitalizations

“Walmart Insulin”

- NPH and Regular insulin are affordable
- Regular insulin: SC: Onset 30-60 min, Peak 2-4 hours
- NPH: SC: Onset 2-4 hours, Peak 4-10 hours


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Rapid-Acting insulin analogs

- ONLY subcutaneous dosing
- Onset 15 - 30 min
- Duration of effect 60 - 90 min
- Prandial dosing (meals, before or during)
- Correction dosing (for elevated BG)

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Correction Insulin Dosing



- **Ask the patient!!!**
- Empirical formulas: 1-4U per 50mg/dl desired decrease
- Rule of 1800 (or 1700 or 1500)
 - Conservative, utilizes insulin sensitivity
 - TDD: Total Daily Dose of Insulin

$1800 \div TDD = \text{mg/dl decrease in BG with each unit of rapid acting insulin given}$

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Correction Insulin Dosing

Use of Subcutaneous Insulin

- Easy to administer (Pt, RN, MD)
- Avoids large and rapid swings in BG
- Replicates normal routine
- Reliable in hemodynamically stable
- Disadvantage: "Stacking"
- Absorption: Abdomen > Arm > Leg
- Timing: Discharge

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Insulin pumps



CSII Continuous Subcutaneous Insulin Infusions

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Insulin Pumps

- 20-30% of Type 1 Diabetics (<400K in US)
- Rapid Acting Analog Insulin
- Basal Functions
 - May be numerous different rates and patterns
 - Perioperatively need **true** basal rate
- Bolus Functions
- Wireless communication
 - Sensor (CGM) response – Need to disable

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Insulin Pumps

- Use the pump to continue basal insulin (*necessary*)
- Know about the pump: ASK!!
- Be prepared to deal with pump failure
- Check BG frequently

An insulin deficient patient's BG will rise 45 mg/dl per hour if insulin is withheld.

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Insulin Pump Success

- Patient should bring:
 - Full reservoir
 - Fresh batteries
 - Extra tubing
- Protocols
- Secure away from surgical field
- Beware Electrical interference

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Should an Insulin-Naïve Pt Receive Insulin to Optimize Blood Glucose Levels?

NO!!!

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What Are Discharge Considerations for Diabetic Outpatients?

What Advice Should We Give to Patients for Glucose Control After Discharge Home?

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PACU and Beyond

- Care continues in the postoperative period
- BG levels may rise
 - Stress, Pain, poor diet
- Need a phone number to call
- Need a family member/support person to help

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What Are Areas for Future Research?

- More research on orals, non insulin injectables
- New insulins
- New orals
- More use of CGM for better data

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